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Mapping an index of the myelin *g*-ratio in infants using magnetic resonance imaging

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ABSTRACT

Optimal myelination of neuronal axons is essential for effective brain and cognitive function. The ratio of the axon diameter to the outer fiber diameter, known as the *g*-ratio, is a reliable measure to assess axonal myelination and is an important index reflecting the efficiency and maximal conduction velocity of white matter pathways. Although advanced neuroimaging techniques including multicomponent relaxometry (MCR) and diffusion tensor imaging afford insight into the microstructural characteristics of brain tissue, by themselves they do not allow direct analysis of the myelin *g*-ratio. Here, we show that by combining myelin content information (obtained with mcDESPOT MCR) with neurite density information (obtained through NODDI diffusion imaging) an index of the myelin *g*-ratio may be estimated. Using this framework, we present the first quantitative study of myelin *g*-ratio index changes across childhood, examining 18 typically developing children 3 months to 7.5 years of age. We report a spatio-temporal pattern of maturation that is consistent with histological and developmental MRI studies, as well as theoretical studies of the myelin *g*-ratio. This work represents the first ever *in vivo* visualization of the evolution of white matter *g*-ratio indices throughout early childhood.